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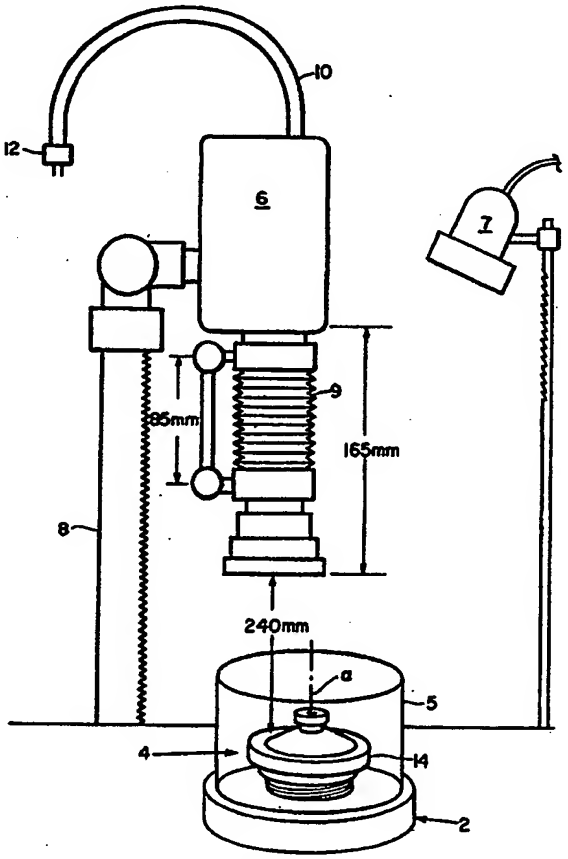
(54) Title: DETERMINING ERYTHROCYTE SEDIMENTATION RATE AND HEMATOCRIT

(57) Abstract

A method and apparatus is disclosed for determining a erythrocyte sedimentation rate and hematrocrit simultaneously with the centrifugation of whole blood. A centrifuge separates the whole blood into its erythrocytes and its fluid portion. A video camera measures the levels of whole blood, erythrocytes, and the fluid portion of the blood and records the time of the formation of an interface between the erythrocytes and fluid portion. A monitor displays the results of the recording. Also disclosed are the method steps performed.



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DETERMINING ERYTHROCYTE SEDIMENTATION RATE AND HEMATOCRIT

Background of the Invention

Daily there are hundreds of thousands of samples of blood drawn in hospitals, medical clinics and doctors' offices for analytical purposes. Some of this blood is analyzed directly as whole blood without being processed. Some is analyzed after separation of the cellular components of the blood (e.g., leukocytes and erythrocytes) from the fluid portion of the blood (plasma or serum).

For example, whole blood can be used for hematological analysis to measure the total concentration of red blood cells and white blood cells in the whole blood, or to prepare blood smears for microscopic analysis of the different types of cells that are present in the blood. Microscopic analysis can be used to diagnose a number of different diseases that might be present, such as certain types of leukemias or anemias. Very commonly, the patient will have a complete blood count (CBC) performed on a whole blood sample. A CBC typically includes a red blood cell (RBC) count, a white blood cell (WBC) count, a differential white blood cell count to identify the types of white blood cells present, a platelet count and the determination of blood parameters such as total hemoglobin and hematocrit.

Alternatively, whole blood can be processed to separate the cellular components from the fluid portion to obtain serum or plasma. Initially, blood is drawn from a patient into a small glass tube. If the tube contains an anticoagulant, the blood does not coagulate (i.e., form a clot) and the cells remain "suspended" in the plasma. If the tube does not contain an anticoagulant, the blood coagulates. The formation of a clot removes certain protein components from the plasma, with serum remaining as the fluid portion of the blood. Processing whole blood to separate cells from plasma/serum is typically accomplished by centrifugation.

Analysis of other physiological parameters can be performed on the plasma or serum, *per se*, which contain extracellular components such as proteins,

Analysis of other physiological parameters can be performed on the plasma or serum, *per se*, which contain extracellular components such as proteins, hormones and electrolytes. A patient undergoing a general physical examination will probably have tests performed on both serum and plasma.

Erythrocyte sedimentation rate (ESR) is one of the traditional tests performed on whole blood in hematology laboratories. ESR measures the distance red blood cells sediment, or fall, in a vertical tube over a given period of time. The measurement of sedimentation is calculated as millimeters of sedimentation per hour and takes greater than one hour to complete. The principle behind ESR is that various "acute phase" inflammatory proteins can affect the behavior of red blood cells in a fluid medium (e.g., decrease the negative charge of RBCs). Inflammatory proteins, such as fibrinogen, will typically appear in the blood, or increase in concentration, during inflammatory processes, such as arthritis. The result is decreased negative charge (zeta-potential) of the erythrocytes that tends to keep them apart, and a more rapid fall of the cells in the analysis tube. The greater the fall of red blood cells in the vertical tube measured at a given period of time, the higher the ESR. A high (i.e., elevated) ESR is indicative of the presence of inflammatory proteins, (i.e., an active inflammatory processes, such as rheumatoid arthritis, chronic infections, collagen disease and neoplastic disease).

The process of collecting the blood specimen and the particular anticoagulant used are crucial in determining an accurate ESR. For example, in one well-known technique known as the Westergren method, blood is collected in the presence of the anticoagulant, sodium citrate, whereas in the modified Westergren procedure, EDTA is used as the anticoagulant. The modified Westergren procedure has become the standard for measuring ESR because it allows the ESR to be performed from the same tube of blood as is used for hematologic studies. Essentially, ESR is a test that has been practiced for decades without much change in the procedure.

Hematocrit (HCT) or packed red blood cell volume is the ratio of the volume of red blood cells (expressed as percentage or as a decimal fraction) to the

volume of whole blood of which the red blood cells are a component. In the micromethod for determining hematocrit, tubes containing whole blood are centrifuged for 5 min at 10-12000 g to separate the whole blood into red cells and plasma. The hematocrit is calculated from the length of the blood column, including the plasma, and the red cell column alone, measured with a millimeter rule. One of the problems with this technique is that it's time consuming and erroneous results may occur as a result of incorrect reading of the levels of cells and plasma or if a significant concentration of plasma becomes trapped within the red cell layer.

It is an object of this invention to measure both erythrocyte sedimentation rate and hematocrit simultaneously with the centrifugation of the whole blood specimen, which is performed for other purposes. In other words, the object is to obtain two critically important blood parameters during the routine centrifugation that is almost universally performed on every blood sample drawn for analytical purposes, without additional manipulation or handling of the blood sample.

Another object is to perform these determinations as rapidly as possible, and have results available much faster than with currently practiced methods.

Summary of the Invention

The invention resides in a method of calculating the erythrocyte sedimentation rate and hematocrit simultaneously with the centrifugation of whole blood for other purposes and apparatus for performing the method.

A sample of whole blood is collected in a container in the presence or absence of an anticoagulant. With the dimensions of the container known, the volume is ascertainable by the blood's level in the container. Thus, the blood level relative to a fixed point in the container need only be measured. A sample is centrifuged to create an interface between the erythrocytes and the plasma or serum. The location of the interface relative to a fixed point in the container is measured as well as the elapsed time between initiating the centrifugation of the blood and the time the interface between the erythrocytes and the plasma or serum

is formed. The time and dimensional factors are measured optically and permanently recorded. The erythrocyte sedimentation rate of the sample is calculated from the elapsed time and the hematocrit of the sample is calculated from the difference between the two measured locations.

The step of measuring the location of the original sample, the interface and the elapsed time of forming the interface is performed by a video camera which records on tape and which is monitored by a video monitor.

A chart comparing the results of measuring erythrocyte sedimentation rate by standard known techniques and that obtained by the above-described method was made to show the correlation of the two techniques. Thereafter, the chart may be referred to in order to obtain erythrocyte sedimentation rate expressed in millimeters per hour (conventional manner) from a measurement of the elapsed time (expressed in seconds) for interface formation.

The above and other features of the invention including various and novel details of construction and combination of parts will now be more particularly described with reference to the accompanying drawings and pointed out in the claims. It will be understood that the particular method and apparatus for determining erythrocyte sedimentation rate and hematocrit embodying the invention is shown by way of illustration only and not as a limitation of the invention. The principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.

Brief Description of the Drawings

Figure 1 is a schematic showing of apparatus for determining erythrocyte sedimentation rate and hematocrit by optical measurement.

Figure 2 is a top plan view on enlarged scale of a centrifuge rotor employed with the apparatus.

Figure 3 is a partial sectional view of the rotor shown in Figure 2.

Figure 4 is a detail sectional view of the rotor on a smaller scale.

Figure 5 is a front view of a video monitor employed with the apparatus.

Figure 6a is a view of the monitor showing a blood sample before centrifugation.

Figure 6b is a schematic showing of the rotor 4 corresponding to Figure 6a with the blood sample before centrifugation.

Figure 7a is a view of the monitor showing the blood sample during centrifugation.

Figure 7b is a schematic showing of the rotor 4 corresponding to Figure 7a showing the blood sample during centrifugation.

Figure 8a is a view of the monitor after the erythrocytes and plasma have been separated.

Figure 8b is a showing of the rotor 4 corresponding to Figure 7a after the erythrocytes and plasma have been separated.

Figure 9 is a chart of ESR expressed as time (sec) to formation of the cell / plasma interface, plotted against ESR in millimeters per hour measured by traditional technique.

Figure 10 is a schematic view of a blood separation tube equipped with an optical sensor (after centrifugation).

Figure 11 depicts one type of a blood separator tube after centrifugation where the red blood cells penetrated thixotropic gel in the tube.

Figure 12 is a view similar to Figure 10 after centrifugation where the red blood cells have not penetrated the gel.

Figure 13 is a schematic view of another embodiment of the centrifuge.

Detailed Description of the Invention

Referring to Figure 1, apparatus is schematically illustrated for determining sedimentation rate of whole blood simultaneously with centrifuging blood for other purposes. A small, high-speed, bench top centrifuge 2 mounts a rotor 4 within a transparent shield 5 for rotation on a vertical axis α. One such centrifuge is sold under the name Stat-Spin® by StatSpin Technologies of Norwood, Massachusetts. A high speed video camera designated NAC HSV-300 is mounted for vertical

adjustment on a stand 8. A continuous light 7 is mounted to project on the rotor 4. An output cable 10 of the camera having a plug 12 leads to a video tape recorder (not shown) and a monitor 24 seen in Figures 5 to 8b.

Secured to the video camera 6 is a lens extension bellows 9, made by the Nikon Company and designated PB-6E. On the forward or lower end of the bellows is a 105mm f.1.8 Nikkor lens. During testing, the bellows was set with an 85mm extension. The lens, through the bellows extension, was 165mm from the shutter of the video camera 6. The front element of the lens was positioned 240mm from the centrifuge rotor 4.

The rotor 4 will be seen in more detail in Figure 4. It is a commercial, circular rotor also made by Stat-Spin Technologies and includes an outer circular flange or rim 14 tapering downwardly and outwardly as viewed in Figure 4 from a central conical portion 16 having a concave bottom 18. The interior of the flange ends at a circular wall 30. The rotor fits on a rotor holder 20 secured by an expandable rubber "O" ring 19. A downwardly, extending projection 21 of the holder 20 secures the rotor holder in the body of the centrifuge 2. The central uppermost portion of the rotor 4 is plugged with a removable stopper 22 (Figure 3).

The video monitor 24 as shown in Figure 5 is of a standard commercially available type measuring 270mm wide and 200mm high. A time code window 26 appears in the upper right hand corner of the screen of the monitor 24 and a specimen identification window 28 is in the upper left hand corner.

Two hundred samples of whole blood from actual hospital patients were analyzed by the conventional modified Westergren technique. A one ml aliquot from each of the prepared whole blood samples was pipetted into its own separate plastic rotor 4 of the type shown in Figures 3 and 4. Each rotor was, in turn, loaded onto the bench top centrifuge 2. The high speed video camera 6 and the strobe light 7 were turned on and centrifugation begun. For each sample, the rotor 4 was spun at 3,500 rpm and the samples were continuously illuminated. The video camera recorded at 200 frames/sec with 1/200 sec exposure time. The

elapsed time in seconds of rotation for each sample was recorded on the video tape within the camera 6 and shown in the time code viewer 26. The time required for the plasma and the red blood cells to form an interface was obtained from the readout of the time code window 26 and by viewing the video tape played back in slow motion. The results were recorded by sample-by-sample as will be described in greater detail hereinafter.

As can be seen in Figures 6a-8b, the relationship between the whole blood (hereinafter designated C + P for cells plus plasma) in the rotor 4 relative to the view on the monitor (and thus the tape) is illustrated. Initially, the whole blood sample was collected in the presence of an anticoagulant, well mixed and placed in the rotor 4. It is shown crosshatched in Figure 6a and 6b. It forms a uniform ring against the inner circular wall 30 of the rotor. The opposite circular edge or height of the blood sample is designated 35. The whole blood appears on the monitor screen as a single wide curved band, designated C + P in Figure 6a and extending from circular band 35 to circular band 30.

As seen in Figures 7a and 7b, in the initial phase of separation, an interface I begins to form between the blood cells C and the plasma P. In other words, the red blood cells C begin moving away from the plasma P.

The interface I migrates progressively outwardly of the axis α of the rotor 4 toward the circular inner wall 30 of the rotor 4. However, when all of the cells C have been separated from the plasma P, the interface I between the cells C and the plasma P reaches a terminal point I_t seen on the screen as a curved line between the bands of plasma P and the cells C. The elapsed time between the initial start of the centrifugation and the time to complete separation (I_t) is determined by the operator reading the time code on the video monitor 26. It is also permanently recorded on the tape for future reference. The actual time of the complete migration of the cells from the plasma was subsequently checked by viewing the video tape in slow motion in the playback mode.

The formation of the terminal interface I_t between the plasma P and the blood cells C was found to be completed within the first 20-45 seconds of centrifugation at 3,500 rpm.

Of the two hundred samples of blood, the ESR of a portion of each sample was measured by the conventional modified Westergren method and of another portion by elapsed time measured as described above. The results for each sample were plotted as will be seen in Figure 9. The time required for the interface formation in the centrifuge inversely correlated with the ESR obtained by the modified Westergren method. The study indicated that measuring ESR by the centrifugation method was not only simpler but much quicker than measuring by the modified Westergren method.

The best fit curve depicted in Figure 9 is valid for the particular apparatus employed. Consequently, if an operator were using the same apparatus, it is only necessary for him to centrifuge blood until the terminal interface (I_t) is formed, record the elapsed time for centrifugation, locate the time on the best fit curve (BFC) and read downwardly to determine the erythrocyte sedimentation rate in millimeters per hour. This could also be done instrumentally.

The above described method represents a simple and quicker alternative to the standard modified Westergren method and may be employed with plastic or glass tubes or other containers containing thixotropic gel, or gel-free tubes or other containers, since the interface formation takes place before the red cells penetrate the gel separation layer.

The same general technique may be employed to ascertain hematocrit (HCT) as is used for ascertaining erythrocyte sedimentation rate (ESR). In determining hematocrit, instead of measuring the elapsed time it takes to form the terminal interface I_t, the quantity of separated red blood cells is measured. As stated above, hematocrit (HCT) or packed red blood cell volume is the ratio of the volume of the red blood cells to the volume of the whole blood from which the cells were separated. It may be expressed as a percentage or as a decimal fraction.

When our technique is employed using the circular rotor 4 as the container for the whole blood being centrifuged, the video camera 6 initially records the location of the circular edge 35 of the whole blood, i.e. its radial distance from the axis of rotation α of the rotor. After centrifugation, the video camera measures the location of the terminal interface I_t radially from the axis of rotation α.

Since hematocrit (HCT) is defined as the volume of the red blood cells divided by the volume of the whole blood from which it was separated, hematocrit maybe calculated as follows: The distance from the axis α (see Fig. 6b) to the circular inner wall 30 of the rotor 4 is known. The distance from the axis α to the interface I_t (see Fig. 8b) is measurable and the distance from the axis α to the original circular edge of the whole blood 35 is measurable. Under ideal circumstances, the HCT would be directly calculable to the two measured distances. The numerator of the fraction would be the distance from axis α to the wall 30 minus the distance from the axis α to the terminal interface I_t. The denominator would be the distance from the axis α to the wall 30 minus the distance from the axis α to the edge 35 of the whole blood. This, however, is only true if the interior of the rotor 4 were uniform, but as will be seen in Figure 4, it is not. Accordingly, the result must be adjusted by a constant or a formula to correct for the irregular configuration. This could lead to complex mathematical calculation.

Another way to compensate for this irregularity is to print on the rotor 4 as seen in Figure 2 a series of concentric rings R_1, R_2, R_3, etc. which are representative of constant volumes of the interior of the rotor. For example, the rotor's volume may be designated in tenths by printing on its surface ten concentric rings R_1 to R_{10}. The rings would not be uniformly spaced *per se*. Their spacing would be determined by the mathematical formula of the internal value of the rotor divided successively by tenths.

A preferred technique, however, is to employ a modified bucket-type centrifuge where the sample containers 56 are conventional commercially available blood centrifuging test tubes of constant diameter and pre-loaded with a quantity of

thixotropic gel G (Figures 10 and 12). The test tube 56 containing a sample of blood (collected in the presence or absence of an anticoagulant) is placed in the centrifuge 50 (to be described in greater detail hereinafter). As seen in Figure 11, after centrifugation, the red blood cells C penetrate the gel G and collect at the base of the test tube. The hematocrit is calculated as follows:

$$H_a = \frac{a-c}{b-c}$$

where c is a constant representing the height of the gel G.

Alternatively, the above calculation could be based upon the relative heights of the red blood cells and the plasma measured before the red blood cells C penetrate the gel G as seen in Figure 12. The formula would then be:

$$H_a = \frac{(h)C}{(h)C+(h)P}$$

Expressed alternatively, HCT is the height of the red blood cells divided by the height of red blood cells plus height of plasma, ignoring the gel. Another alternative way of expressing the result is the sum of the heights of red blood cells and height of gel divided by the collective height of the plasma, the red blood cells and the gel.

Figure 13 is a schematic diagram of a centrifuge employing a conventional integrated serum separated tube style of the type sold under the trade name CORVAC by Sherwood Medical, St. Louis, Missouri for performing the techniques described with reference to Figures 11 and 12. The centrifuge may be positioned below the video camera 6 of the type shown in Figure 1. It has a base 50 and an upstanding rotor shaft 52. A gimbel 54 is pivoted at 58 on the rotor shaft 52. The separator tube 56 is gripped by a clamp of the gimbel 54. A counterweight 60, if needed, may also be pivotally mounted on the rotor shaft 52. The centrifuge is rotated at 3500 RPM for about three minutes. During centrifugation, the separator tube 56 being mounted by the gimbel 54 attains a

horizontal position that is indicated by the dotted line β in Figure 13 whereupon it is in the best possible position to be photographed by the video camera 6, i.e. with the tube 56 at right angles to the axis of the lens of the video camera.

The video camera measures and records the distance from the bottom of the separator tube 56 to the gel/plasma interface designated a in Figure 11. It also measures distance from the bottom of the tube 56 to the plasma air interface designated b in Figure 10. The same type of measurement would apply to Figure 12.

The HCT measurement can be performed separately or following the sedimentation rate determination described above since the sedimentation rate is ascertained in the first 20 to 45 seconds of centrifugation.

Another possible embodiment is disclosed in Figure 10 wherein the separator tube 56, which would be centrifuged by apparatus similar to that shown in Figure 13, would include an optical source and sensor 62 associated with the tube. Lead wires 64, 66 would lead to a microprocessor (not shown) which would continuously feed data to the tape and the video monitor 24, or other means of detecting the interface formation by its optical properties. By use of this technique, the video camera and strobe are eliminated and a plurality of separated tubes could be centrifuged simultaneously and the results recorded simultaneously.

CLAIMS

The invention claimed is:

1. A method of calculating erythrocyte sedimentation rate simultaneously with the centrifugation of whole blood comprising the steps of:

obtaining a sample of whole blood;

centrifuging the whole blood;

separating out the erythrocytes;

forming an interface between the erythrocytes and the fluid portion of the blood;

measuring the elapsed time from initiating the step of centrifuging to the formation of the interface; and

calculating the erythrocyte sedimentation rate of the sample from the elapsed time.

2. A method of calculating hematocrit simultaneously with the centrifugation of whole blood comprising the steps of:

obtaining a sample of whole blood;

loading the sample of whole blood into a container;

measuring the location of the whole blood relative to a fixed point in the container;

centrifuging the blood sample;

separating out the erythrocytes;

creating an interface between the separated erythrocytes and the fluid portion of the blood;

measuring the location of the interface relative to the fixed point in the container; and

calculating the hematocrit of the sample from the difference between the two locations.

3. A method of calculating erythrocyte sedimentation rate and hematocrit simultaneously with the centrifugation of whole blood comprising the steps of:

obtaining a sample of whole blood;

loading the sample of whole blood into a container;

measuring the location of the whole blood relative to a fixed point in the container;

centrifuging the whole blood;

separating out the erythrocytes;

creating an interface between the erythrocytes and the fluid portion of the blood;

measuring the e2lapsed time from initiating the step of centrifuging to the formation of the interface;

measuring the location of the interface relative to the fixed point in the container;

calculating the erythrocyte sedimentation rate of the sample from the elapsed time; and

calculating the hematocrit of the sample from the difference between the two locations.

4. Method according to Claim 1 wherein the step of measuring is optical.

5. Method according to Claim 2 wherein the step of measuring is optical.

6. Method according to Claim 3 wherein the step of measuring is optical.

7. Method according to Claim 1 wherein the step of measuring is by video camera photography.

8. Method according to Claim 2 wherein the step of measuring is by video camera photography.

9. Method according to Claim 3 wherein the step of measuring is by video camera photography.

10. Method according to Claim 1 wherein the step of measuring includes the steps of recording the time of the formation of the interface and analyzing the recording optically.

11. Method according to Claim 2 wherein the step of measuring includes the steps of recording the time of the formation of the interface and analyzing the recording optically.

12. Method according to Claim 3 wherein the step of measuring includes the steps of recording the time of the formation of the interface and analyzing the recording optically.

13. Method according to Claim 1 wherein the step of calculating includes the steps of analyzing a portion of each sample by standard techniques and comparing the results for each sample.

14. Method according to Claim 2 wherein the step of calculating includes the steps of analyzing a portion of each sample by standard techniques and comparing the results for each sample.

15. Method according to Claim 3 wherein the step of calculating includes the steps of analyzing a portion of each sample by standard techniques and comparing the results for each sample.

16. Method according to Claim 1 wherein the step of calculating includes the steps of analyzing a portion of each sample by standard techniques, comparing the results for each sample and plotting the compared results.

17. Method according to Claim 2 wherein the step of calculating includes the steps of analyzing a portion of each sample by standard techniques, comparing the results for each sample and plotting the compared results.

18. Apparatus for determining erythrocyte sedimentation rate and hematocrit simultaneously with the centrifugation of whole blood comprising:

a container for holding a sample of whole blood;

a centrifuge for separating the whole blood into its erythrocytes and its plasma;

means for measuring and recording the volume of whole blood, the erythrocytes, and the plasma; and

a monitor for displaying the results of the recordings.

19. Apparatus according to Claim 18 wherein the measuring and recording is performed by a video camera.

20. Apparatus according to Claim 18 wherein the measuring is performed by an optical sensor.

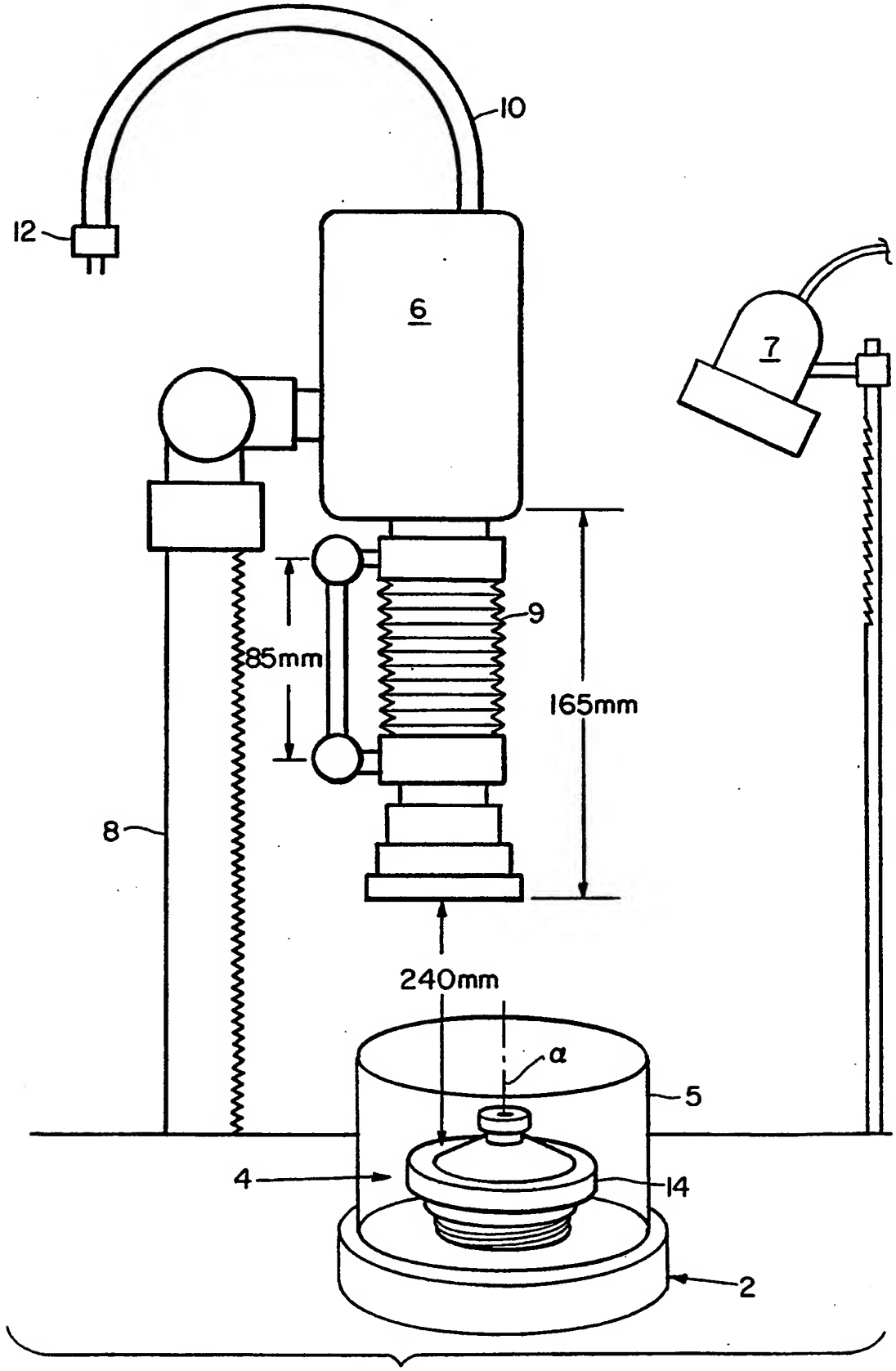

FIG. 1

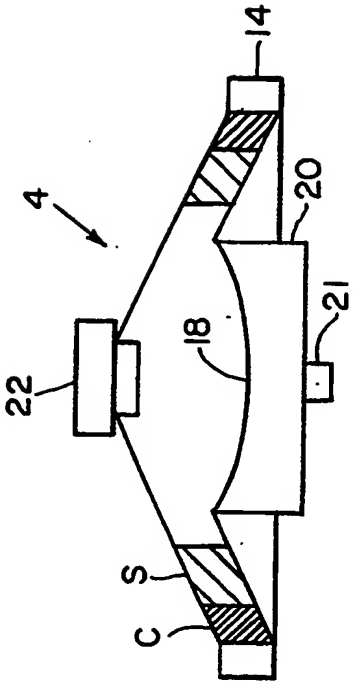

FIG. 3

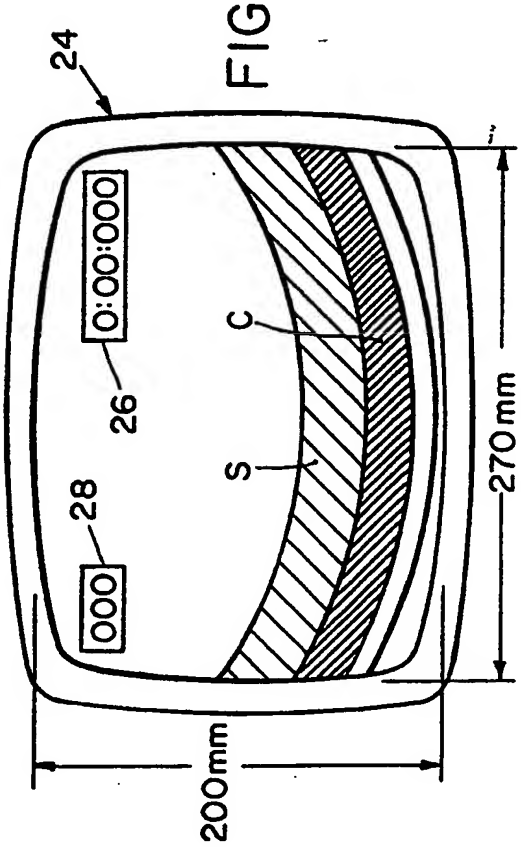

FIG. 5

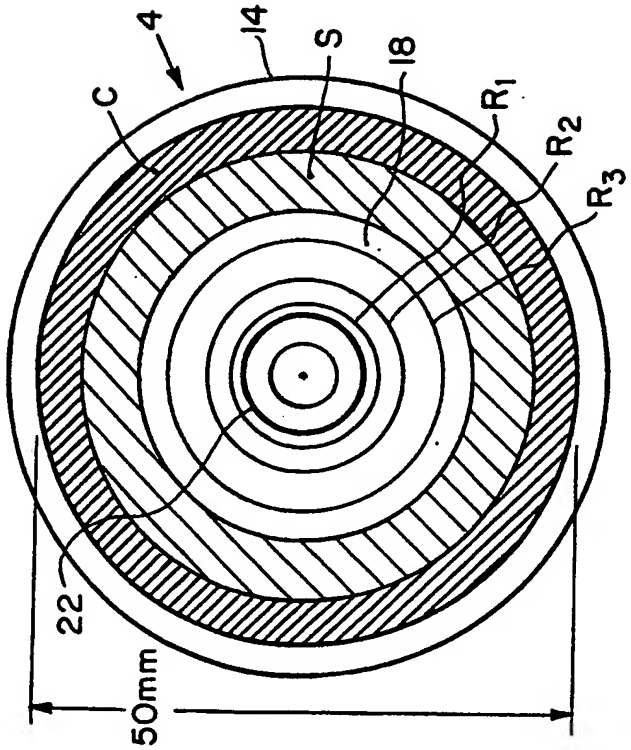

FIG. 2

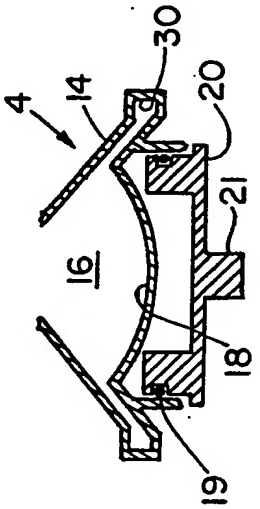

FIG. 4

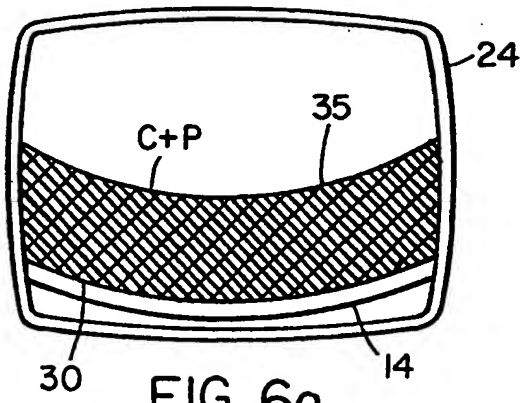

FIG. 6a

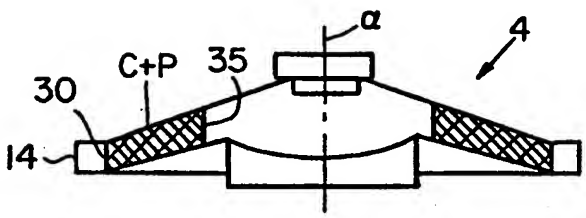

FIG. 6b

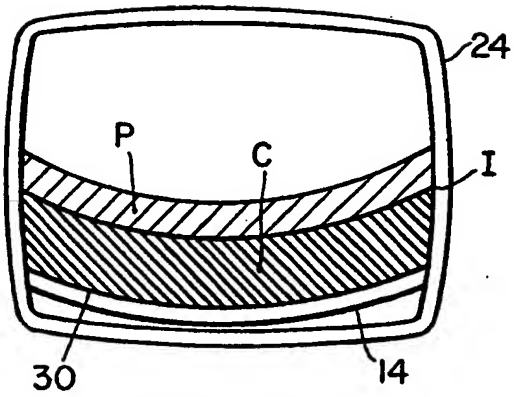

FIG. 7a

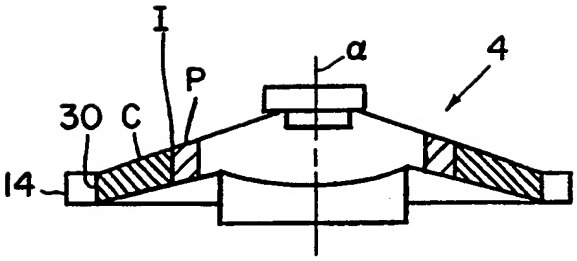

FIG. 7b

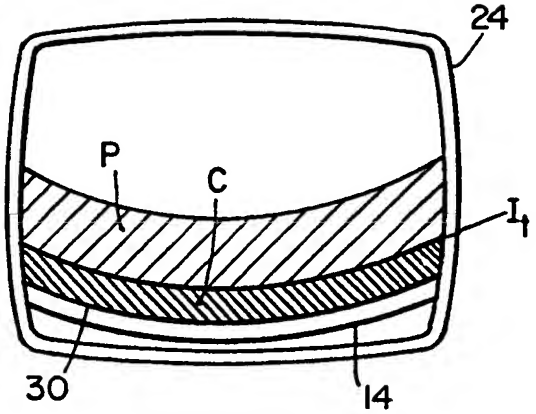

FIG. 8a

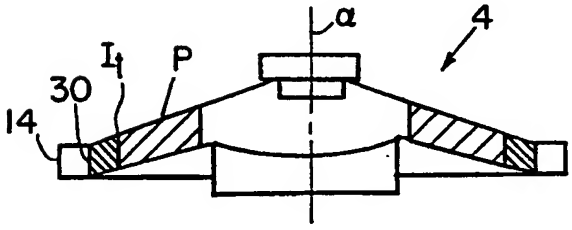

FIG. 8b

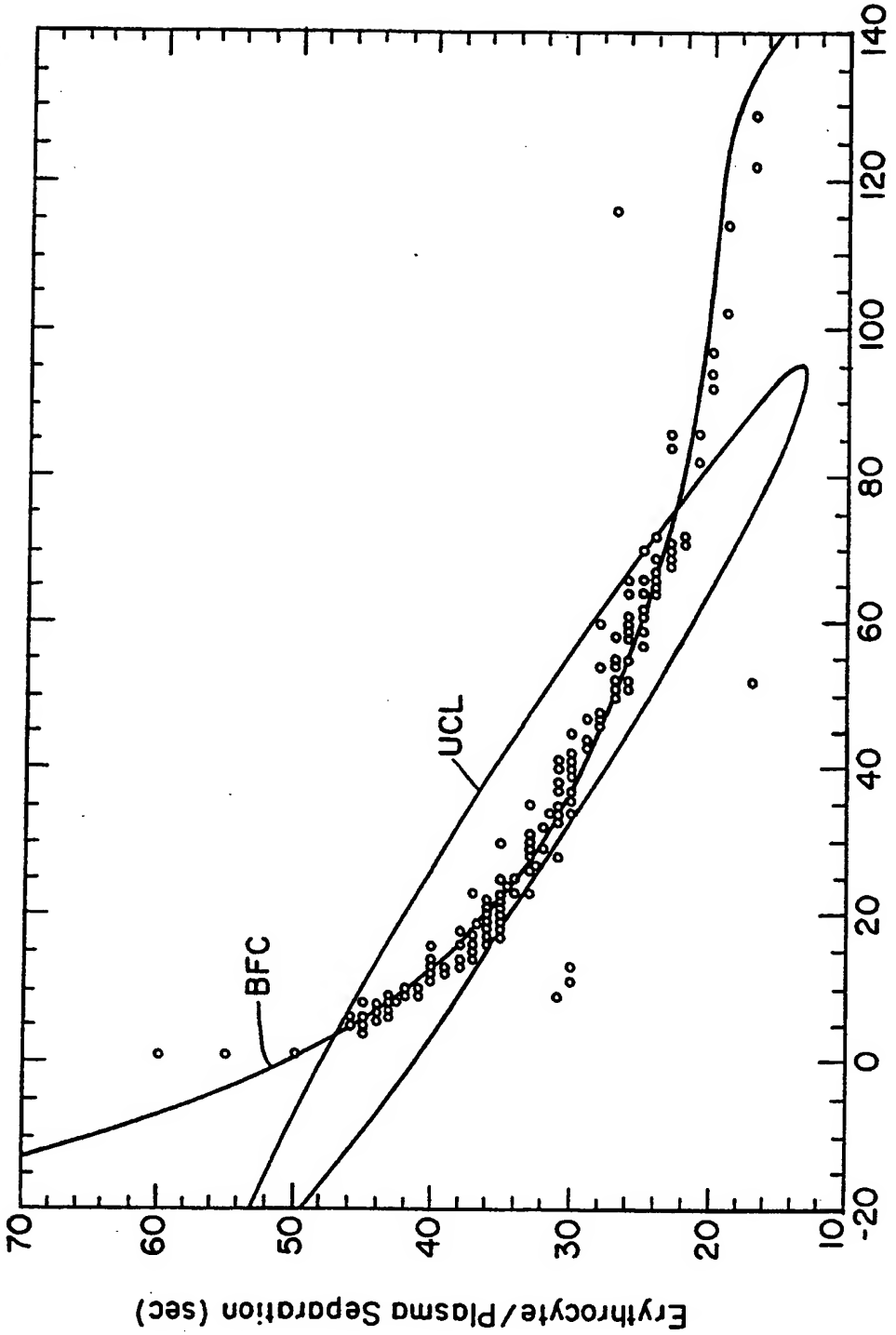
Erythrocyte/Plasma Separation (sec)
70
60
50
40
30
20
10
-20
0
20
40
60
80
100
120
140
Erythrocyte Sedimentation Rate (mm/hr)
UCL
BFC

FIG. 9

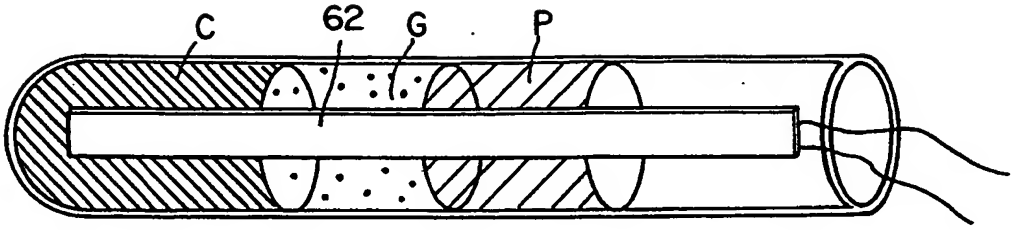

FIG. 10

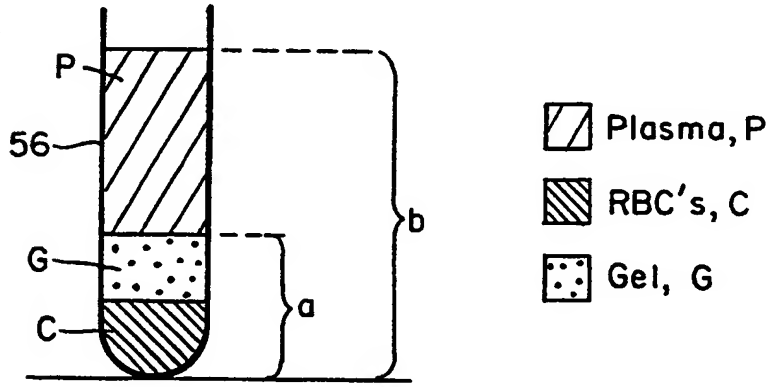

FIG. 11

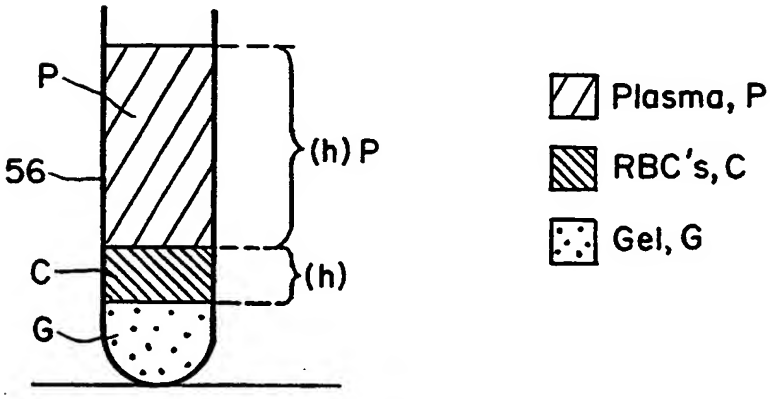

FIG. 12

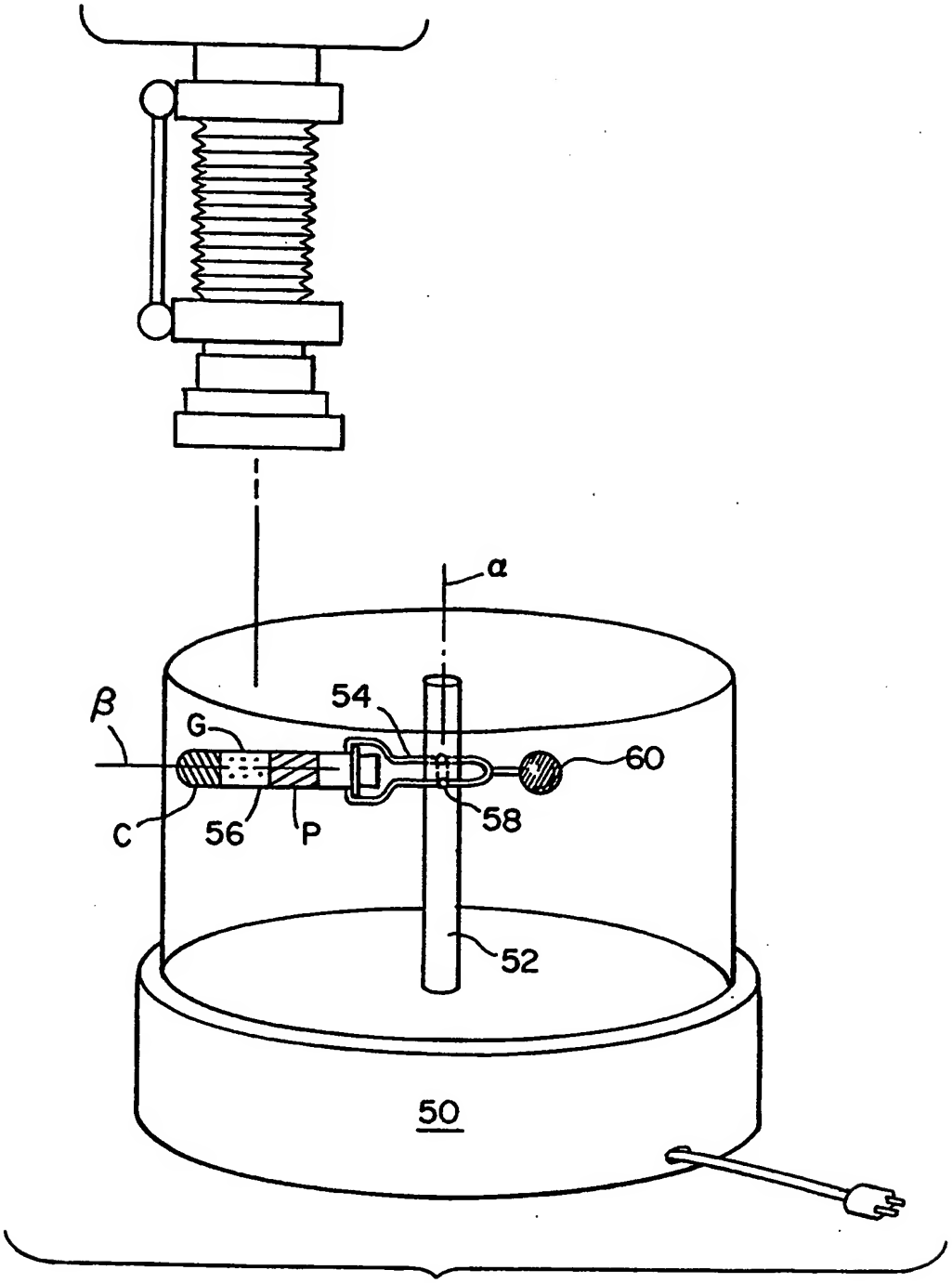

FIG. 13

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 96/07864

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01N15/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 1 214 144 A (M. RENE-JEAN HARDY) 6 April 1960	1,3
X	see page 1, column 2, paragraph 3 - page 2, column 1, paragraph 3 see page 2, column 2, paragraph 3 see figures 1-4	18-20

A	US 3 199 775 A (K. G. DRUCKER ET AL.) 10 August 1965	1,3
X	see column 5, line 16-53	2,18-20

A	FR 2 435 714 A (CLINICON INTERNATIONAL GMBH) 4 April 1980	1,3
X	see page 2-4 see figures 1,2	18-20

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 September 1996	25.09.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Zinngrebe, U

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 96/07864

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A X	US 3 824 841 A (BULL) 23 July 1974 see column 5, line 55 - column 7, line 50 see column 8, line 25-31	1-3 18-20
A	BIOMEDIZINISCHE TECHNIK, vol. 39, no. 1-2, January 1994, GERMANY ISSN 0013-5585, pages 8-12, XP000601722 DSCHIETZIG T. ET AL.: "sedimentation analyser - calibration and testing of a new device for recording the separation behaviour of blood and other dispersed systems" see page 9	1-3

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte nal Application No
PCT/US 96/07864

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR-A-1214144	06-04-60	NONE		
US-A-3199775	10-08-65	NONE		
FR-A-2435714	04-04-80	DE-A-	2838783	20-03-80
		BE-A-	878610	05-03-80
		JP-A-	55038000	17-03-80
		SE-A-	7907342	07-03-80
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		CA-A-	961019	14-01-75
		CH-A-	553980	13-09-74
		DE-A-	2204447	24-08-72
		DE-A-	2246675	26-04-73
		FR-A-	2126724	06-10-72
		FR-A-	2156607	01-06-73
		GB-A-	1376664	11-12-74
		GB-A-	1399486	02-07-75
		NL-A-	7200771	10-08-72
		NL-A-	7212820	25-04-73
		SE-B-	375920	05-05-75
		US-A-	2126724	16-08-38
		US-A-	3768727	30-10-73